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PULMONARY FUNCTION TESTING IN MILITARY PERSONNEL: A PRELIMINARY STUDY

Lieutenant Robert Bason, MSC USNR and

Commander David R. Stoop, MC USN

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NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY

PENSACOLA FLORIDA

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Bureau of Medicine and Surgery
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NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY
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SUMMARY PAGE

THE PROBLEM

The military community is made up of a very diverse group of individuals representing a random sample from all walks of life and geographical locations. Although these individuals are supposedly healthy, an increasing number of them are later being diagnosed as having irreversible early obstructive ventilatory mechanics. While the magnitude and scope of the problem is largely unknown since it has not been adequately researched, the problem, nevertheless, is believed to be significant and alarming by general medical officers and flight surgeons.

The present report is part of a larger study aimed at detecting cardiopulmonary disease among military personnel. This report describes the pulmonary function data obtained on these people.

FINDINGS

1. Pulmonary functions decreased progressively and significantly with age, an observation that is in keeping with other studies.

2. The single most important feature of this study was the high mechanics observed in the 20-24 year age group. Whereas most studies such as this reflect disease statistics in patients already symptomatic, this investigation reveals a significant percentage (23.5%) of the yet asymptomatic young age group who have the beginning of a long-term process.

3. The early obstructive ventilatory mechanics observed in the 20-24 year age group were not related to smoking habits.

INTRODUCTION

An alarming increase in the death rate from pulmonary insufficiency has occurred over the past few years. For example, the Public Health Service in 1966 reported over 25,000 deaths due to chronic bronchitis and emphysema. This represented a 25% increase over the previous year (1). In 1967, the Social Security Administration paid ninety million dollars in benefits to people affected with the two diseases. This represented 7% of all disability payments and made pulmonary obstructive disease second only to heart disease.

The military community is made up of a very diverse group of individuals representing a random sample from all walks of life and geographical locations. Although these individuals are supposedly healthy, an increasing number of them are later being diagnosed as having irreversible early obstructive ventilatory mechanics. While the magnitude and scope of the problem is largely unknown since it has not been adequately researched, the problem, nevertheless, is believed to be significant and alarming by general medical officers and flight surgeons.

The present report is part of a larger study aimed at detecting cardiopulmonary disease among military personnel. This report describes the pulmonary function data obtained on these people.

METHOD

The subjects involved in this study comprised incoming Naval Aviation Cadets and designated aviators at Naval Air Station, Pensacola.

Routine spirometry was done using a Sanborn 211 and the Med-Science Wedge Spirometer 370. Expiratory and inspiratory curves were also recorded on magnetic tapes for computer analysis. While standing, the subject inhaled maximally from room air through a three-way valve, then exhaled with maximal force and speed into the wedge spirometer. A paper recording demonstrated the validity of the curve. Final analysis of total volume, forced expiratory volumes (one second, two seconds and three seconds) and flow rates (maximal 200-1200 and 25-75%) rested with the computer (2, 3). All values were reported in BTPS uncorrected for resting conditions. Nose clips were used.

Each subject performed three trials and the best trial, i.e., the one with the highest forced vital capacity was used in the statistical analysis.

All anthropometric measurements were made according to standard techniques and are described in an earlier report (4).

The subjects were divided into three age groups: 20-24 year old group, 25-34 year old group and the 40-49 year old group. There were no subjects between the ages of 35-39. Each age group was further divided into "normals" and those who were diagnosed as having pulmonary disease, according to the criteria set forth in Table 1.

RESULTS

Pulmonary functions for the "normal" and " diseased" groups are shown in Figure 1 and summarized in Table II.

As can be seen from this figure, all of the pulmonary functions regardless of diagnostic group exhibited identical trends, i.e., a progressive decrease with age with a more precipitous drop in the 40-49 year old group. This value was significantly lower (p .05) than the other two age groups for all pulmonary functions for both the "normals" and the "diseased" groups. As would be expected, those subjects diagnosed with pulmonary disease had significantly (p .01) lower overall pulmonary functions than the "normals" for each age group.

Anthropometric measurements are summarized in Table III and some are graphically displayed in Figure 2. No significant differences were observed between identical age groups for any of the variables measured. Chest circumference measured during maximum expiration and inspiration tended to increase with age beyond the 25-34 year old group for both the "normals" and "diseased" groups. This increase, however, was not statistically significant.

Smoking habits of the two groups might conceivably differ enough to influence lung functions. However, in this study, 56% of the "normal" group were smokers, and 57% of the "diseased" group were smokers. Furthermore, there were no differences in either the quantity or the duration of smoking. In the 20-24 year old group, the "normals" smoked an average of 15 cigarettes per day for an average of 5 years while the "diseased" group averaged 14 cigarettes per day for 5.4 years. In the 40-49 year old group the "normals" smoked an average of 18 cigarettes per day for 20 years while the "diseased" group averaged 7.5 cigarettes per day for 8 years. This "diseased" group, however, had only a sample size of two and one of these was a non-smoker.

DISCUSSION

It has been known that the pulmonary functions decrease progressively and significantly with age. The decreases observed in this study are in keeping with the observations made by others (5-8). This decrease is largely attributed to a loss of lung elastic recoil and seems to occur sometime after 34 years of age. The tendency toward increased chest

Table 1

Criteria Used to Establish Restrictive and Obstructive Pulmonary Disease

MEASUREMENT	AGE 0 - 39	DIAGNOSIS	AGE ≥ 40	DIAGNOSIS
FEV 1 Sec.% / FVC	≥ 75 < 75	Normal OPD*	≥ 70 < 70	Normal OPD
FEV 2 Sec.% / FVC	≥ 94 < 94	Normal OPD	≥ 90 < 90	Normal OPD
FEV 3 Sec.% / FVC	≥ 97 < 97	Normal OPD	≥ 94 < 94	Normal OPD
MEFR (200-1200 ml flow rate ml/sec) MALE	≥ 7000 < 7000	Normal OPD	≥ 4000 < 4000	Normal OPD
FEMALE	≥ 4000 < 4000	Normal OPD	≥ 4000 < 4000	Normal OPD
MMF (25% & 75% flow rate ml/sec) MALE	≥ 3400 < 3400	Normal OPD	≥ 2000 < 2000	Normal OPD
FEMALE	≥ 3000 < 3000	Normal OPD	≥ 2000 < 2000	Normal OPD
FVC** (% of predicted) Vital capacity	≥ 80 < 80	Normal Consistent with Restrictive Disease		

INTERPRETATION

A. All trials are considered in the Diagnosis.
B. All predicted normal values are based on age, sex, and height.

Normal

The predicted normal for each measurement must be achieved in one of the trials to receive a diagnosis of normal.

Consistent with Restrictive Disease. (Vital Capacity)

This diagnosis is made when all trials fall below 80% of predicted vital capacity.

Consistent with Obstructive Pulmonary Disease. (FVC 1, 2, 3, Sec.%, MEFR, MMF)

This diagnosis is made when the predicted value fails to be achieved in any of the measurements in all trials.

Consistent with Restrictive and Obstructive Pulmonary Disease is diagnosed when the above criteria for both diagnoses are fulfilled.

Formula used to predict the vital capacity.

In Male cc = 27.63-(0.112xage) x ht. cm
In Female cc = 21.78-(0.101xage) x ht. cm

* OPD Obstructive Pulmonary Disease.

** Forced Vital Capacity

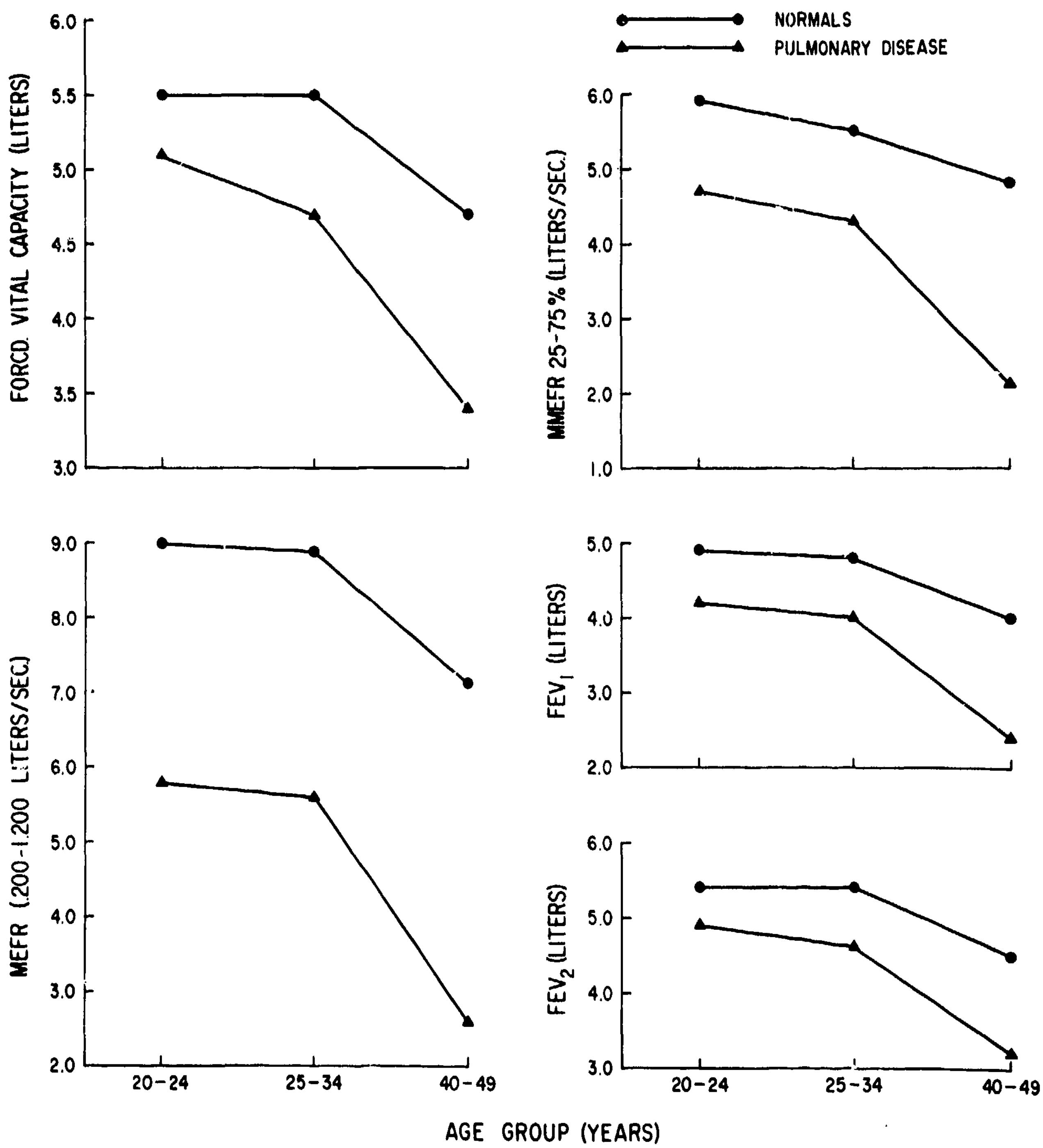

Figure 1

Lung Volume Measurements by Age Groups

Table II

Pulmonary Function Measurements Arranged by Diagnostic Group and According to Age

		AGE 20 - 24				AGE 25 - 34				AGE 40 - 49			
		NO	MEAN	S.D.	RANGE	NO	MEAN	S.D.	RANGE	NO	MEAN	S.D.	RANGE
FORCED VITAL CAPACITY (FEV) - LITERS	NORMAL	179	5.45	.90	3.58-9.95	26	5.51	.71	4.21-6.79	37	4.68	.72	3.58-4.32
	DISEASED	55	5.06	1.06	2.17-7.47	7	4.73	.56	4.28-5.91	2	3.44	.80	2.64-4.25
FEV_1 - LITERS	NORMAL	179	4.86	.76	3.31-9.14	26	4.80	.59	3.79-6.42	37	4.00	.76	2.58-6.79
	DISEASED	55	4.23	.82	1.82-6.24	7	3.99	.27	3.61-4.41	2	2.41	.48	1.93-2.89
FEV_1 / FEV - %	NORMAL	179	88.90	5.50	73-100	26	87.00	5.60	75-99	37	84.80	6.60	76-100
	DISEASED	54	84.10	10.47	40-98	7	84.60	6.20	74-92	2	70.50	2.50	68-73
FEV_2 - LITERS	NORMAL	179	5.39	.89	3.58-9.95	26	5.41	.67	4.19 6.56	37	4.52	.73	3.09-6.79
	DISEASED	55	4.94	1.00	2.17-7.29	7	4.58	.43	4.15-5.55	2	3.16	.70	2.45-3.86
FEV_3 - LITERS	NORMAL	179	5.45	.90	3.58-9.95	26	5.49	.70	4.19-6.77	37	4.65	.73	3.18-6.79
	DISEASED	55	5.05	1.05	2.17-7.44	7	4.69	.53	4.27-5.88	2	3.41	.79	2.63-4.20
MEFR (200-1200 ml) LITERS / SEC	NORMAL	179	8.96	1.78	4.71-15.47	26	8.86	1.45	6.37-12.03	37	7.06	1.47	4.01-10.00
	DISEASED	55	5.78	1.22	1.35-8.33	7	5.59	1.03	3.73-6.77	2	2.61	1.00	1.61-3.61
MMEFR (25-75%) LITERS / SEC	NORMAL	179	5.88	1.24	3.22-11.83	26	5.53	1.09	4.03-8.53	37	4.83	1.99	2.37-13.13
	DISEASED	55	4.66	1.06	1.78-6.61	7	4.35	.58	3.88-5.36	2	2.07	.21	1.86-2.28

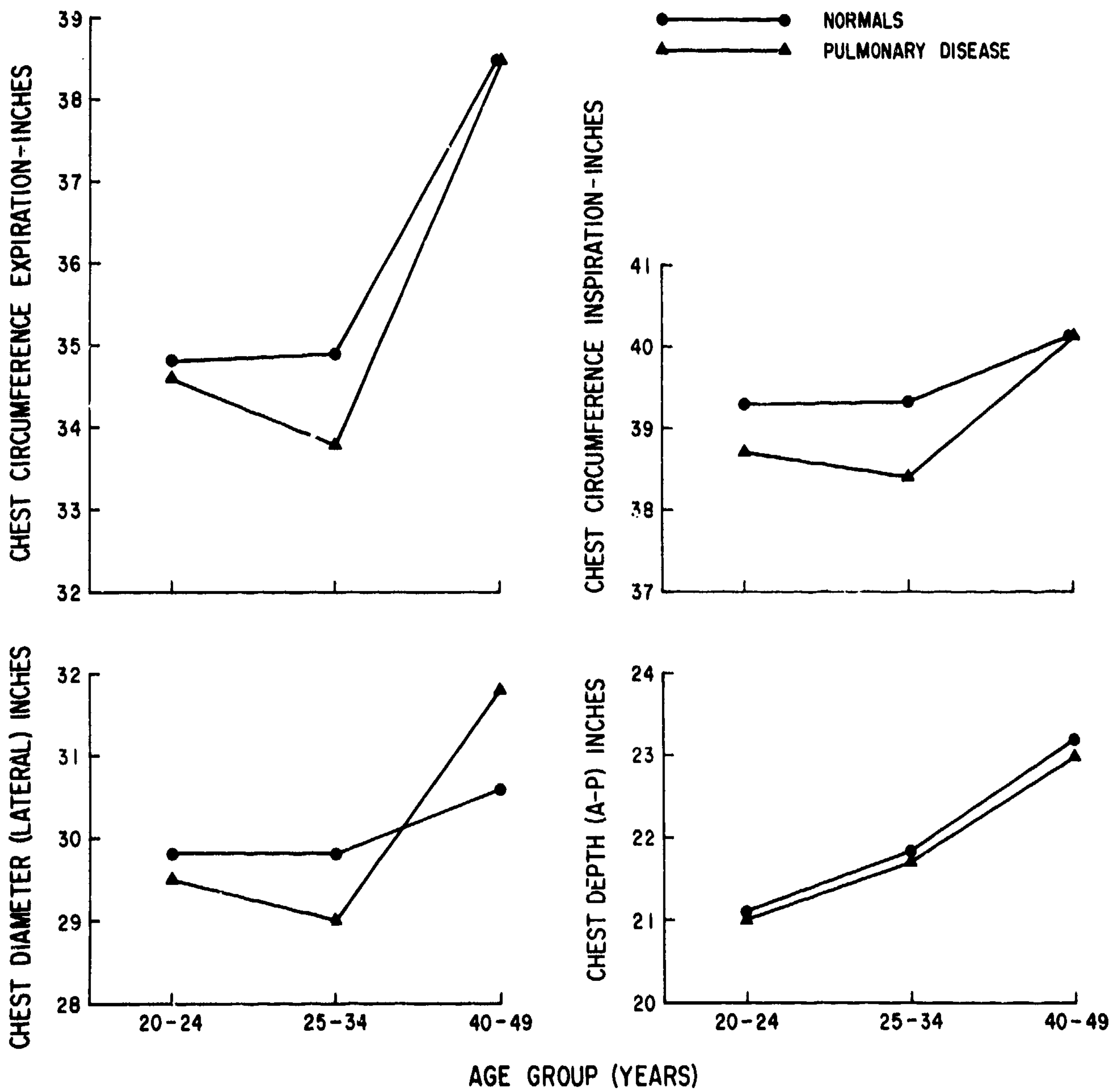

Figure 2

Anthropometric Measurements by Age Group

circumference, observed in this study, suggestive of larger closing volumes wouid tend to support a loss of elastic recoil. The steep fall off in pulmonary functions in the older age group is in agreement with the work of Hutchinson (9) and Berglund (10).

The reason for the significant differences in pulmonary functions between the "normal" and the "diseased" group is unclear. There are a number of factors which could be responsible for these differences. These would include anthropometric differences, smoking habits, motivation, geographic location and early respiratory illness to name a few. The differences could also be a fortuitous finding in a single study.

It is unlikely that anthropometric measurements were responsible for the differences in pulmonary functions. As was shown in Table III, there were no significant differences in any ot the anthropometric measurements obtained.

Smoking habits of the two groups might conceivably differ enough to influence lung functions. However, in this study, 56% of the "normal" were smokers and 57% of the "diseased" group were smokers. Furthermore, there was no difference in either the quantity of the duration of smoking. This is not a contradiction to virtually all other studies that have shown lung impairment among cigarette smokers (11-15). A comparison of smokers and non-smokers in this study did in fact show lower overall pulmonary functions for smokers than non-smokers, however, the differences were not significant. What this does say, however, that since both the "normal" and the "diseased" groups had approximately the same percentage of smokers who smoked the same amount and for the same duration, smoking should have influenced the two groups equally and therefore, should not have been a contributing factor for the observed differences.

It is difficult to ascertain the role that motivation or improper technique played in accounting for the differences. Each group performed three trials and the best of the three trials was used in reporting the data. Furthermore, it is highly unlikely that motivation and proper technique or the lack of it would have been limited to just one group and not the other.

It was not determined whether geographic location, i.e., environmental conditions or early respiratory illness could have been responsible for the observed difference. It is also unlikely because of the large sample size, that this was a fortuitous event occurring in a single study.

The single most important feature of this study was the high incidence, for whatever reasons, of early obstructive ventilatory mechanics observed in the 20-24 year old age group. Whereas most studies such as

Table III

Anthropometric Measurements Arranged by Diagnostic Group and According to Age

		AGE 20-24				AGE 25-34				AGE 40-49			
		NO	MEAN	S.D.	RANGE	NO	MEAN	S.D.	RANGE	NO	MEAN	S.D.	RANGE
HEIGHT - INCHES	NORMAL	179	70.77	2.45	65-78	26	70.25	2.70	64-76	37	69.44	2.75	58-74
	DISEASED	55	69.16	8.80	66-76	7	69.57	2.60	66-74	2	71.00	4.00	67-75
WEIGHT - POUNDS	NORMAL	179	167.82	18.41	125-135	26	170.77	2.80	112-185	37	175.19	15.85	145-210
	DISEASED	55	163.60	17.88	120-196	7	160.57	11.82	140-181	2	188.50	31.50	157-220
SITTING HEIGHT INCHES	NORMAL	178	36.83	1.23	33-42	25	36.56	1.15	34-39	37	36.85	1.06	35-39
	DISEASED	55	36.78	1.16	35-40	7	37.25	2.74	26-31	2	37.65	1.85	36-40
CHEST DIAMETER INCHES	NORMAL	143	29.81	1.94	23-36	23	29.78	2.40	26-35	37	30.60	2.06	27-38
	DISEASED	54	29.50	1.76	26-34	7	29.04	1.45	26-31	2	31.85	.55	31-32
CHEST DEPTH INCHES	NORMAL	143	21.13	1.72	17-26	23	21.80	1.69	17-25	37	23.19	3.64	19-42
	DISEASED	54	20.95	1.81	17-26	7	21.70	2.55	19-27	2	22.95	1.85	21-25
MAXIMUM INSPIRATION INCHES	NORMAL	177	39.33	2.44	34-51	26	39.31	2.68	34-47	37	41.04	5.34	40-46
	DISEASED	55	38.76	2.38	34-45	7	38.43	.94	37-40	2	41.00	1.00	40-42
MAXIMUM EXPIRATION INCHES	NORMAL	177	34.86	1.92	31-40	26	34.92	2.50	30-42	36	38.47	5.29	40-45
	DISEASED	55	34.60	2.21	31-41	7	33.79	1.53	31-37	2	38.50	1.50	37-40

this reflect disease statistics in patients already symptomatic, this current investigation reveals a significant percentage (23.5%) of the as yet asymptomatic young age group who have the beginnings of a long-term process. This is quite alarming in such a young age group that supposedly represents the "cream of the crop" in health. It is further deemed important to note that rather than search retrospectively for the early signs of chronic obstructive airway disease, that more information such as provided herein be sought first of all to ascertain whether the observed pulmonary function values obtained in this study for the 20-24 year old group are real, i.e., not a chance finding in a single study; if it is real to account for it and discuss its impact on physical performance especially with regard to aviators flying high performance aircraft and finally to validate the criteria for early obstructive ventilatory mechanics and possible reversible changes as has been suggested in the literature (16). These young people are clearly the people at risk for future complications and the earlier they are identified the better chance there likely will be of interrupting the otherwise inexorable course.

In this regard, the Aviation Medicine Division of the Naval Aerospace Medical Research Laboratory is presently undertaking a long-term pulmonary function study in hopes of identifying early obstructive pulmonary mechanics in young aviators.

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13. ABSTRACT

The military community is made up of a very diverse group of individuals representing a random sample from all walks of life and geographical locations. Although these individuals are supposedly healthy, an increasing number of them are later being diagnosed as having obstructive ventilatory mechanics.

This study is concerned with the pulmonary function results of a supposedly healthy population of Naval Aviation Officer Candidates and designated Naval Aviators at Naval Air Station, Pensacola, Florida.

The data suggest a high incidence of obstructive ventilatory mechanics in a relatively young age group (20-24 years old). Whereas most studies such as this reflect disease statistics in patients already symptomatic, this current investigation reveals a significant percentage (23.5%) of the as yet asymptomatic young age group who have the beginnings of a long-term process.

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